NOTES AND NEWS

INHIBITION OF *Abies concolor* RADICLE GROWTH BY EXTRACTS OF *Ceanothus velutinus*.—*Ceanothus velutinus* Dougl. ex Hook is a major shrub species that invades recently burned areas and clearcuts at middle elevations in the Sierra Nevada, California, where it competes strongly with natural and planted conifer seedlings (Conard and Radosevich, Forest Sci. 28:243–304, 1982; Zavitkovski et al., J. For. 67:242–245, 1969). Establishment of natural *Abies concolor* (Gord. & Glend.) Lindl. seedlings in brush fields with a high cover of *Ceanothus velutinus* is frequently spotty, and many established seedlings appear somewhat unhealthy for several years. The earlier study by Conard and Radosevich was concerned primarily with competitive interactions. Chemical (allelopathic) effects, however, are also a possible partial explanation for reduced growth of conifers in the presence of *Ceanothus velutinus*. To investigate this possibility, I conducted a series of laboratory and growth chamber experiments.

Methods. The first two experiments compared germination and growth of *Abies concolor* seedlings under *Ceanothus velutinus* canopies and without *Ceanothus* canopies. Seeds were germinated in 1.4-liter pots containing either a 20- to 25-cm tall *Ceanothus* seedling or no seedling (control). Pots were filled with potting mix (1:1:: peat:sand plus balanced fertilizer). Twenty *Abies* seeds were placed in each pot, with two pots per treatment. Seeds were watered regularly with distilled water. Seeds in the *Ceanothus* treatment were watered through the shrub canopy. To minimize potential moisture competition, the soil was kept near field capacity at all times in both treatments. Both experiments were conducted in a controlled environment chamber (23°C day, 10°C night, 16-h photoperiod). Average daytime light intensity was 0.6 mmol m^{-2} sec^{-1}.

In the first experiment, germination was recorded after 1 month, and a random sample of eight seedlings selected from each treatment was measured for root and shoot length. In the second experiment, the treatments were the same as those described, except that the seedlings were grown for 7 weeks, at the end of which germination and survival were recorded. This experiment was repeated three times, with two pots per treatment each time.

On the basis of the results of these first two experiments, and of a series of extremely inconclusive experiments that had been designed to look at possible effects of *Ceanothus* root exudates on *A. concolor* seedlings (S. Conard, unpubl. data), I hypothesized that the *Ceanothus* foliage was the most likely source of allelopathic compounds. To test this hypothesis, I conducted two additional experiments to examine more closely the effects of *Ceanothus velutinus* foliage extracts on radicle growth of germinating *Abies concolor* seeds. Leaf extracts were prepared by soaking crushed, fresh-frozen *Ceanothus* foliage for 1 h in enough distilled water to cover the leaves. Leaves and water were placed in a Waring blender (trade names are used for information only; no endorsement by the U.S. Department of Agriculture is implied) for 3 min. The resulting mixture was strained through cheesecloth and vacuum-filtered through Whatman No. 1 filter paper to remove suspended solids. The osmolality of these extracts was measured with a vapor pressure osmometer (Wescor, Model 5130) to determine if observed effects could be attributed to osmotic potential of the extracts. Extracts were stored in the refrigerator for up to 2 weeks until use.

In one experiment, standard glass-chromatography plates were covered with chromatography filter paper that had been moistened and rolled to remove air bubbles. Plates were set on an angle in covered plastic trays with their bottom edges in 250 ml of either *Ceanothus* extract or distilled water. A row of five *Abies concolor* seeds was placed 2.5 cm from the top edge of each plate. On half of the plates, seeds were

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covered with a 2.5-cm wide strip of chromatography paper moistened with distilled water. Each of the four treatment combinations was replicated twice. Radicle growth and germination were recorded 10 and 22 days after the beginning of the experiment, which was conducted at room temperature (20° to 25°C) in indirect sunlight in the laboratory.

In a second similar experiment, seeds were germinated in 1-pint plastic freezer containers. A 1-cm thick pad of open-cell foam placed in the bottom of each container was covered with a square of chromatography paper cut so it could be folded over the edges of the foam to contact the bottom of the container and act as a wick for treatment solutions. Nine seeds of *Abies concolor* were placed in a square grid in each container. The same two treatment solutions were used in this experiment as in the previous one. To minimize fungal attack, 10 mg captan was added per 450 cc of each treatment solution. Twenty ml of the appropriate treatment solution was added along the edges of each freezer container after the foam pad and seeds were in place. Containers were covered with plastic wrap and placed on a windowsill in the laboratory. Each treatment was replicated three times. Germination, radicle growth, emergence of cotyledons, and evidence of fungal attack or root dieback were recorded 21 days after the start of the experiment.

Results of all experiments were analyzed by analysis of variance. In experiments with more than two treatments, the least significant difference (LSD) was used to compare treatments. Arcsine square-root transformations were applied to percentage data where appropriate.

Germination. Germination of seeds grown with *Ceanothus* and watered through their canopies averaged 47%. This germination was not significantly different (paired $t = 0.1727$, $df = 3$) from germination in control pots (45%). I also observed no significant differences in germination among treatments in either the chromatography plate bioassay or the foam pad bioassay, where germination averaged across treatments was the same (78% ± 4 SD) for both experiments. Germination percentages observed in the two bioassay experiments ranged from 60 to 89%. Because treatments appeared not to affect germination, seeds that did not germinate were omitted from calculations of growth parameters.

Survival. Although treatments did not affect germination, they substantially affected survival after 7 weeks. The survival rate of *Abies* seedlings grown in pots with *Ceanothus* (0.20 ± 0.02 SE) was significantly lower ($p < 0.005$) than survival of seedlings grown in the same soil without *Ceanothus* (0.81 ± 0.06 SE).

Radicle growth. The germinated *Abies* seedlings that were harvested in the first experiment showed dramatically different patterns of root growth, despite nearly identical shoot growth (Table 1). I also observed that the roots of seedlings that had been germinated in pots with *Ceanothus velutinus* were withered and broke off readily, whereas roots of the controls were healthy. With chromatography plate and foam pad bioassays I more closely evaluated the possible effects of *Ceanothus* foliage extracts on root growth of germinating *Abies* seedlings in the absence of potentially confounding variables such as moisture competition, shading, and root exudates. In the chromatography plate bioassay, radicle growth of germinated *Abies* seeds averaged 126.8 ± 3.6 mm for the control and 71.2 ± 1.2 mm for the control with filter paper strips. Values for the comparable treatments with *Ceanothus* extract were 45.4 ± 0.1 mm for the control and 55.6 ± 11.8 mm for the control with filter paper strips. All differences, except between the two extract treatments, were statistically significant at the 0.1 level or greater.

The foam pad bioassay produced similar results, with average radicle growth of 5.3 ± 0.6 mm for seeds exposed to the *Ceanothus* treatment and 41.9 ± 3.8 mm for seeds exposed to the distilled water treatment. The extract treatments showed highly significant decreases ($p < 0.001$) in radicle growth compared with those of the control. No differences were observed among treatments in the degree of fungus attack (range = 3–16%) or the number of radicles with tip dieback (16–25%). Significantly more of

TABLE 1. STEM AND ROOT GROWTH OF *Abies concolor* SEEDLINGS GROWN FOR 1 MONTH IN POTS WITH OR WITHOUT *Ceanothus velutinus* (±ONE STANDARD ERROR).

Treatment	Stem length (cm)	Root length (cm)
Ceanothus	3.3 ± 0.3	2.4 ± 0.2
Control	3.5 ± 0.3	11.4 ± 0.4

the seedlings in control treatments, however, had cotyledons emerged at the end of the experiment (44%) than those in the *Ceanothus* extract treatment (0%). The osmolality of *Ceanothus* extract used in these experiments was 77 ± 1 mOS/kg (about -1.8×10^{-3} MPa). It is unlikely, therefore, that osmotic potential of the solutions affected the results to any great degree.

Discussion. The results of these experiments suggest the possibility of an allelopathic inhibition of radicle growth of *Abies concolor* seedlings by *Ceanothus velutinus.* At least one compound (cinnamic acid), found by Craig et al. (Phytochemistry 10:908, 1971) in the leaves of *C. velutinus* has been implicated as inhibiting seedling growth in some species (Rice, E. L., 1974, Allelopathy, Acad. Press, NY, p. 256). Further experiments are required to isolate the causes of the responses described here and to determine whether extracts of foliage and litter produced under field situations are sufficiently concentrated and persistent to have measurable effects. If responses similar to those described here are observed in the field, *Ceanothus velutinus* may be expected to affect adversely the natural regeneration of *Abies concolor*—especially in dry years or in other situations where rapid root growth could be critical to seedling survival.— SUSAN G. CONARD, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S.D.A., 4955 Canyon Crest Dr., Riverside, CA 92507. (Received 16 Feb 1984; accepted 30 Oct 1984.)

PITFALLS IN IDENTIFYING *Ventenata dubia* (Poaceae).—The annual Eurasian grass species *Ventenata dubia* (Leers) Coss. & Dur. appears to be expanding its range in the Pacific Northwest, and botanists who may encounter it need to be aware of some pitfalls in making a correct identification of this potential weed. Its occurrence as an adventive species in Idaho and Washington was first reported by Baker (Leafl. Western Bot. 10:108–109. 1964), and it was subsequently described and illustrated by Hitchcock et al. (Vasc. Pl. Pac. N.W. 1:724. 1969). A recent collection from Polk County (*Halse 2857,* 21 Jun 1984, OSC) documents its invasion of the Willamette Valley in western Oregon. The spread of *V. dubia* by human agency may accelerate if it becomes a contaminant of the various crop grasses grown for seed in the Pacific Northwest.

Ventenata is generally considered to be taxonomically allied with *Trisetum* and *Avena* (Hackel, The true grasses, Henry Holt and Co., 1890, p. 121; Bews, The world's grasses, Longmans, Green and Co., 1929, p. 174). The two upper florets of its 3-flowered spikelets are fertile; as commonly occurs in members of tribe Aveneae, these lemmas bear a conspicuous dorsal, geniculate awn. The lowest floret, however, is usually staminate, and its lemma has a straight terminal awn, as is found in various members of tribes Poeae, Brachyeltreae, Stipeae, etc. This floret is incorrectly described as awnless by Gould and Shaw (Grass systematics, Texas A&M Univ. Press, 1983, p. 179) and Hackel (op. cit.). Both glumes are shorter than the first lemma, and disarticulation occurs in the rachilla above the lowest floret.

Because the dorsally-awned florets are shed at maturity and the terminally-awned one is retained within the glumes, this grass is deceptive when presented for identi-